МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ

НАЦІОНАЛЬНИЙ ТЕХНІЧНИЙ УНІВЕРСИТЕТ
"ХАРКІВСЬКИЙ ПОЛІТЕХНІЧНИЙ ІНСТИТУТ"

МЕТОДИЧНІ ВКАЗІВКИ

до практичних занять з курсу «Міжнародна логістика»
для студентів спеціальностей
073 «Менеджмент»
076 «Підприємництво, торгівля та біржова діяльність»

INTERNATIONAL SUPPLY CHAIN MANAGEMENT STUDY GUIDE

International Logistics Course
for undergraduate students. Majors: 073 “Management"
076 «Entrepreneurship, Trade and Exchange Activity»

Харків 2020

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INTRODUCTION

In connection with the formation of market relations, a new scientific and practical direction has appeared and began to actively develop in our country. This direction is logistics.

Logistics is now being used due to modern economic realities. But despite this, logistics is still not so much in demand by domestic business as in foreign countries, where the history of its development has been around for half a century.

The growing interest in logistics in Ukraine cause a need of the training of specialists of relevant qualifications. It’s early to talk about the training of full–fledged specialists in this field in Ukraine, since the experience of training in this field in industrially developed countries lasts several decades. But the discipline "International Logistics" has already become an integral part of the curriculum of many universities in Ukraine. An important role in mastering the discipline "Logistics" plays the solution of problems.

In these guidelines, the main numerical methods that are used in the course "International Logistics" are considered. Each section is dedicated to a separate topic of the course. All sections are constructed in the same way: first, the necessary theoretical information, then a detailed course of solving problems, and at the end of each section, options for individual homework. Variants of the tasks should be selected by the student’s last name in the group’s journal. The instructions also contain control questions to test students' knowledge.

This publication cannot replace the textbooks on logistics, because the theoretical basis is presented in a condensed form. There is only that information that is necessary directly for solving problems. It might be recommended as textbooks [1–5].

1 PURCHASING LOGISTICS

Purchasing logistics is the management of material flows in the process of providing enterprises with material resources.

The purpose of purchasing logistics is the adequate and complete satisfaction of production requirements for materials with the highest possible economic efficiency. The basis of economic efficiency is the search and purchase of the necessary materials of satisfactory quality at the lowest prices.

An effective method for solving procurement logistics problems is **to analyze the full cost**. Full cost analysis means taking into account all economic changes that occur during any changes in the logistics system.

Using a full cost analysis implies the possibility of varying prices in the search for solutions (the possibility of increasing costs in one area, if in general this leads to savings in the system).

1.1 Problem "Make or Buy"

The company produces and sells three components. The task of the management of the supply department was to explore prices in the world market. Such price and cost indicators were explored (table 1.1).

Table 1.1 – Initial information for making a management decision "to make or buy"

Indicators	Component		
	X	*Y*	*Z*
Production volume, units	20000	40000	80000
Cost of basic materials per unit of production, UAH	0.8	1.0	0.4
Labor costs of the main production workers (per unit of output), UAH	1.6	1.8	0.8
Direct costs per unit of production, UAH	0.4	0.6	0.2
Fixed costs per unit of production, UAH	0.8	1	0.4
Unit selling price, UAH	4.0	5.0	2.0
Import purchase price, UAH	2.75	4.2	2.0

1. Provide recommendations to the management of the company about the possibility of purchasing a component based only on costs.

2. Determine the amount of profit in case of self–production of all components.

3. Establish whether purchasing recommendations (point 1) will affect profit and to what extent.

Solution. When developing recommendations on the possibility of purchasing a component, it is necessary to take into account only the relevant costs and revenues (those expenses and revenues, the amount of which directly depends on the decision made). The costs of two alternatives – procurement or own production – are presented in table 1.2.

Table 1.2 – Comparative analysis of two alternatives (procurement or own production)

Relevant costs	Component					
	X		*Y*		*Z*	
	production	procure ment	production	Procure ment	production	procure ment
Cost of basic materials per unit of production, UAH	0.8	–	1.0	–	0.4	–
Labor costs of the main production workers (per unit of output), UAH	1.6	–	1.8	–	0.8	–
Direct costs per unit of production, UAH	0.4	–	0.6	–	0.2	–
Import purchase price, UAH	–	2.75	–	4.2	–	2.0
Total relevant unit costs, UAH.	2.8	2.75	3.4	4.2	1.4	2.0

The results of the calculations, based only on the costs, show that the company makes sense to buy component X.

Calculate the amount of profit in the case of own production of all components of the table 1.3.

Table 1.3 – Calculation of the amount of profit in the case of own production of all components

Indicators	Component		
	X	*Y*	*Z*
1. Production volume, units	20000	40000	80000
2. Cost of basic materials per unit of production, UAH	0.8	1.0	0.4
3. Labor costs of the main production workers (per unit of output), UAH	1.6	1.8	0.8
4. Direct costs per unit of production, UAH	0.4	0.6	0.2
5. Fixed costs per unit of production, UAH	0.8	1	0.4
6. Cost of one unit of production, UAH	3.6	4.4	1.8
7. Unit selling price, UAH	4.0	5.0	2.0
8. Profit from one unit of production, UAH	0.4	0.6	0.2
9. Profit for the entire production volume, UAH	8000	24000	16000
10. Total profit, UAH	48000		

Let's calculate the amount of profit, taking into account the recommendations given in table 1.2.

Table 1.4 – Calculation of the cumulative profit margin (procurement and own production)

Indicators	Component		
	X (procurement)	*Y* (production)	*Z* (production)
1. Production volume, units	20000	40000	80000
2. Cost of basic materials per unit of production, UAH	–	1.0	0.4
3. Labor costs of the main production workers (per unit of output), UAH	–	1.8	0.8
4. Direct costs per unit of production, UAH	–	0.6	0.2
5. Fixed costs per unit of production, UAH	0.8	1	0.4
6. Import purchase price, UAH	2.75	–	–
7. Cost of one unit of production, UAH	3.55	4.4	1.8
8. Unit selling price, UAH	4.0	5.0	2.0

9. Profit from one unit of production, UAH	0.45	0.6	0.2
10. Profit for the entire production volume, UAH	9000	24000	16000
11. Total profit, UAH	49000		

Thus, the calculations showed that if it is used the combined option, the company will be able to make a profit of 49 thousand UAH, which is one thousand UAH more as self–production of all components.

Problem 1.1 for Self–Studying: "Make or Buy"

For your version of the output (Table 1.5), solve the task of making or buying.

Table 1.5 – Initial information for management decision to make or buy

Indicators	Component		
	X	*Y*	*Z*
Production volume, units	20000*k	40000*k	80000*k
Cost of basic materials per unit of production, UAH	0.8*k	1.0*k	0.4*k
Labor costs of the main production workers (per unit of output), UAH	1.6*k	1.8*k	0.8*k
Direct costs per unit of production, UAH	0.4*k	0.6*k	0.2*k
Fixed costs per unit of production, UAH	0.8*k	1*k	0.4*k
Unit selling price, UAH	4.0*k	5.0*k	2.0*k
Import purchase price, UAH	2.75*k	4.2*k	2.0*k

The coefficient of the variant of the task is determined by the formula

$$k = \frac{100 + N}{100}, \qquad (1.1)$$

where N is the student's last name in the group journal.

1.2 Problem "The choice of oil product transportation"

Firm N, which organizes and implements forwarding and transportation of export, import and transit cargo, signed a contract for the delivery of 21,000 tons of oil products from the Kharkov oil refinery (Ukraine) to a new oil depot built on the territory of Moldova in Palanka.

The network of railways and highways in the region, the layout of transport enterprises, transshipment tank farms and consumer tank farms, is shown in Fig. 1.1. The numbers on the diagram indicate the distances between objects, expressed in kilometers.

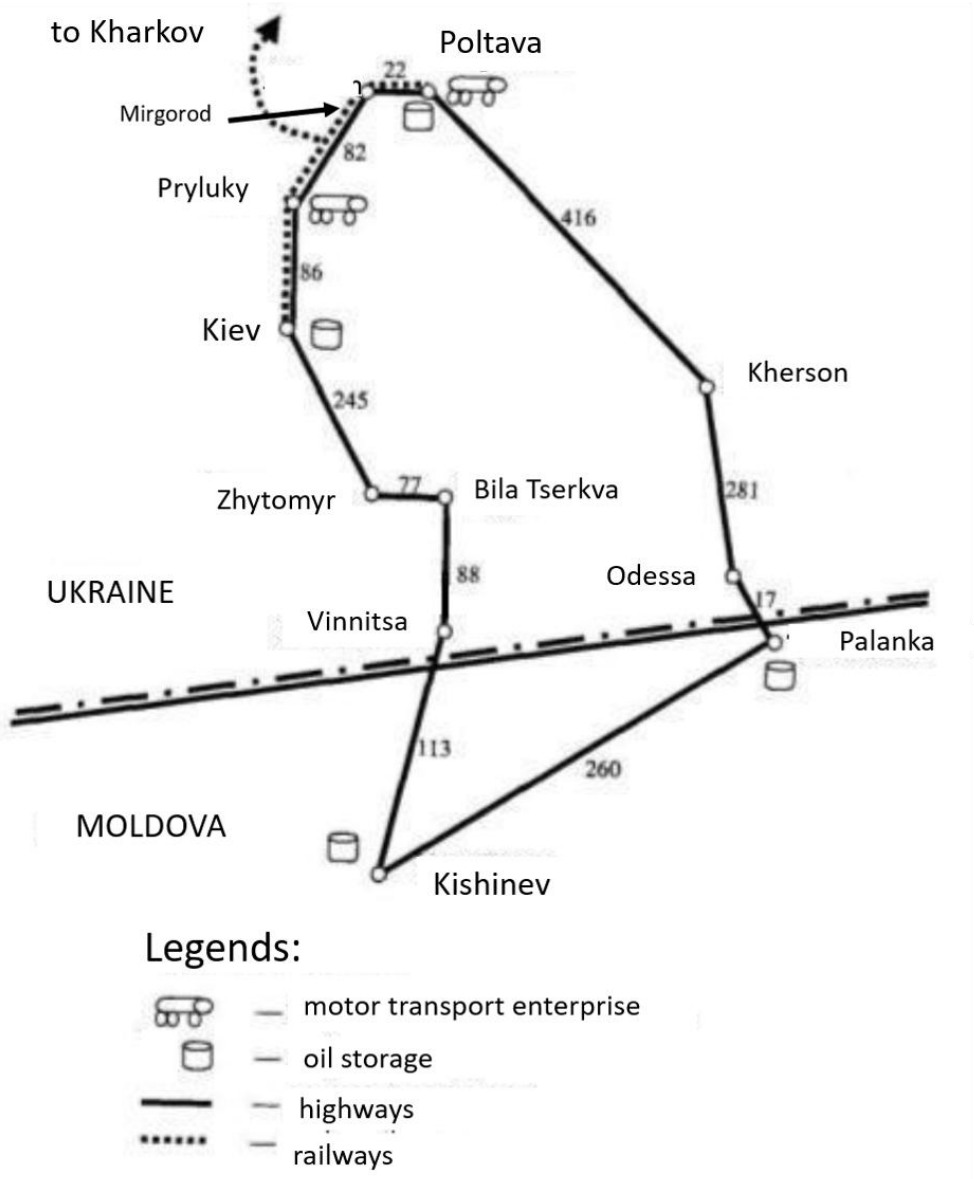

Figure 1.1 – Scheme of the transportation

Transportation is carried out in two stages.

The first stage: by rail from Kharkov to the oil depots of Poltava or Kiev. The cost of delivering petroleum products by rail from the Kharkov Oil Refinery to these oil bases is the same, it does not affect or account for the calculations.

Second stage: by road to Palanka.

To secure these supplies, N contracts with transportation companies and oil depots to transport and store oil products. There are two transport companies in the region that meet the requirements offered for international road transport carriers: first – in Pryluky, second – in Poltava. There are also two oil depots in the region: in Kyiv and in Poltava, which are closest to their final destination and capable of handling and storing the required volume of petroleum products.

It is necessary to choose the optimal scheme of transportation of petroleum products, using as a criterion the minimum total cost. Possible variants of transportation schemes are given in table 1.6.

Table 1.6 – Options for transportation schemes of petroleum products

Indicator	Variant 1	Variant 2	Variant 3
Transshipment	Through the tank farm in Kiev	Through the tank farm in Poltava	Through the tank farm in Poltava
Carrier	Pryluky motor company	Pryluky motor company	Poltava motor company
Route	Kiev– Kishinev – Palanka	Poltava –Kherson – Palanka	Poltava –Kherson – Palanka

Decision. The choice of a scheme for the transportation of petroleum products is based on the calculation of various options. The selection criterion is a minimum of total costs. Calculations are carried out in several stages.

1. Using the data in table 1.7, as well as the values of the distances indicated in Fig. 1.1, calculate the cost of transportation *Cp* oil products for each option.

Table 1.7 – Tariffs for transportation, dollars / ton

Pryluky motor company	0,06
Poltava motor company	0,064
Mongolian transport	0,09

The domestic tariff for transportation in Mongolia (0.09 dollars per ton) is significantly higher than the tariffs of Ukrainian motor transport enterprises engaged in international transportation due to the lack of heavy rolling stock, the high cost of fuel, as well as a number of other factors. The calculation results will be entered in table 1.9.

2. Calculate the cost of supplying vehicles for loading C_{supply}. Tariff for supplying vehicles to the place of loading T_{supply} = 0.2 dollars / km. Due to the fact that the location of transport enterprises and oil depots in the first and second variants do not coincide, there are costs associated with supplying transport for loading. The cost of supply is determined by the formula:

$$C_{supply} = T_{supply} * N * L, \quad (1.2)$$

where L is the distance between the transport company and the tank farm, km; N – the number of flights required to perform a given volume of traffic, calculated by the formula:

$$N = \frac{Q}{q}, \quad (1.3)$$

where Q is the total volume of traffic equal to 21,000 tons under the contract; q – vehicle load capacity is taken in the calculation of the average truck load capacity of 15 tons.

The calculation results should be included in the table 1.9.

3. Using the data in table 1.8, we determine the cost of transshipment of oil products at oil depots. The calculation results should be included in the table 1.9.

Table 1.8 – Tariff cost of transshipment of petroleum products, dollars / t

Tank farm	Tariff
Kiev tank farm	7
Poltava tank farm	10

4. We calculate the total cost of the three options for transportation schemes. The calculation is made in the form of a table 1.9.

Table 1.9 – the calculation of the total cost of transportation schemes oil products

Cost	Variants		
	1	2	3
Transportation	1150380	899640	959616
Transport feed	24080	29120	0
Transshipment	147000	210000	210000
TOTAL	1321460	1138760	1169616

Answer: in accordance with the criterion of minimum total costs, it is necessary to choose a second scheme for the transportation of petroleum products.

Problem 1.2 for Self–Studying: "Selection of a scheme for the transportation of petroleum products"

For your source data option, select the optimal transportation scheme for petroleum products, using the minimum total cost as a criterion.

Initial data:

Tariffs for transportation, USD / tkm

Pryluky motor company	0,06*k
Poltava motor company	0,064*k
Mongolian transport	0,09*k

Tariff for delivery of transport to the place of loading $T_{supply} = 0.2*k$ *(USD./km).*

Tariff cost of transshipment of petroleum products, USD / t

Tank farm	Tariff
Kiev tank farm	7*k
Poltava tank farm	10*k

1.3. Problem "Selection of a geographically remote supplier based on full cost analysis"

The company *M* is located in Kiev and is engaged in the wholesale of food products. The main suppliers of the company *M* are also located in Kiev. A supplier from the city of *N* offers the company *M* goods at prices cheaper than Kiev. The purchase of goods from a supplier in the city of *N* will result in the following additional costs: transportation costs, diversion of funds to stocks (in transit and insurance stocks), freight forwarding costs.

Initial data:

1. The tariff cost of transportation from the city of *N* to Kiev is the same for all goods and amounts to 3000 UAH. per 1 m3 of cargo.

2. The delivery time is 10 days.

3. In the case of deliveries from the city of *N*, the company is forced to create insurance stocks for the maximum estimated delay time for delivery, which is half the delivery time (5 days).

4. The costs of maintaining reserves in transit and insurance reserves are calculated on the basis of interest rates on a bank loan – 36% per annum (3% per month, 0.1% per day).

5. The cost of forwarding is 2% of the value of the goods.

6. The goods delivered to the company by Moscow suppliers are packaged and subject to mechanized unloading. A supplier from N delivers packaged goods that need to be unloaded manually. The difference in the cost of unloading is on average 200 UAH. / m^3.

It is necessary to determine which of the items in the assortment of the company M it is advisable to buy in the city of *N*, and which in Kiev.

Decision. The appropriateness of the purchase is estimated based on the construction and use of the supplier selection curve, the abscissa axis represents the purchase cost of 1 m3 of cargo in the city *N*, and the ordinate axis represents the share of the additional costs of delivering 1 m3 of this cargo from the city *N* to Kiev in its purchase price in city *N* (in %). To calculate the share of additional costs, fill out table 1.10.

Table 1.10 – Calculation of the share of additional costs in the unit cost of cargo

Purchase cost, UAH. / m^3 (*OX*)	Additional costs for the delivery of 1 m^3 of cargo from the city of *N*						The share of additional costs in the purchase value, % *(OY)*
	Transport tariff, UAH / m^3	Stocks in transit, UAH	Insurance stocks, UAH	Forwarding, UAH (2 %)	The difference in unloading, UAH / m^3	Total additional costs	
1	2	3	4	5	6	7	8
5000	3000	50	25	100	200	3375	67,5
10000	3000	100	50	200	200	3550	35,5
20000	3000	200	100	400	200	3900	19,5
30000	3000	300	150	600	200	4250	14,2
40000	3000	400	200	800	200	4600	11,5
50000	3000	500	250	1000	200	4950	9,9
70000	3000	700	350	1400	200	5650	8,1
100000	3000	1000	500	2000	200	6700	6,7

1. On the basis of columns 1 and 8 of table 1.10 construct a supplier selection curve (Fig. 1.2).

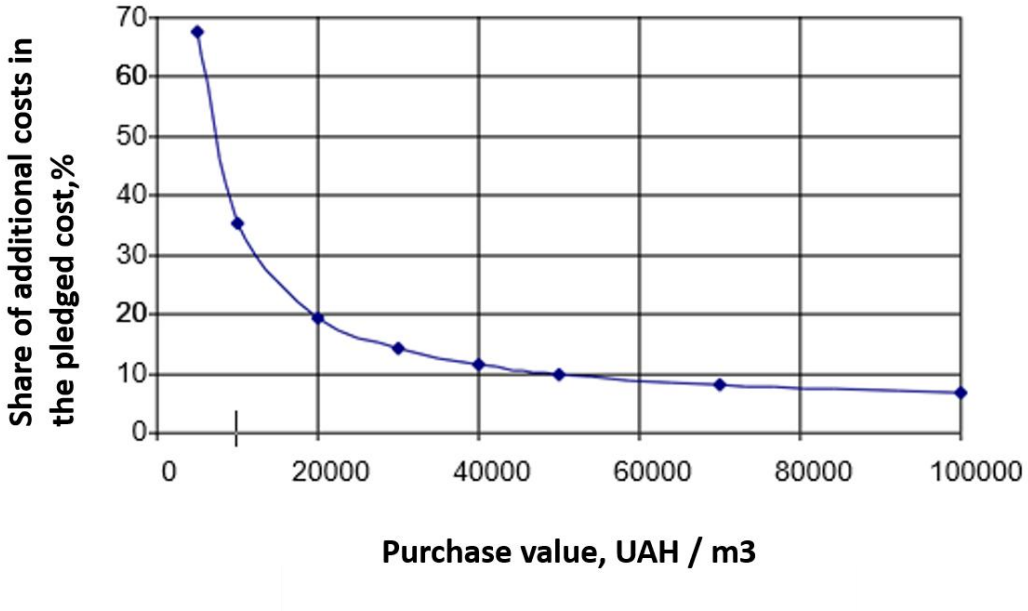

Figure 1.2 – Supplier selection curve

2. We will calculate in percent the difference in the prices of suppliers from Kiev and the city of *N* and make a table 1.11.

Table 1.11 – Characteristics of purchased assortment

Name of the product range of company *M*	The cost in the city of *N*, UAH. / m^3	Price, UAH / unit		The difference in prices,% (price in the city *N* – base)	Conclusion on the appropriateness of procurement in the city *N*
		In the city *N*	Kiev		
1	2	3	4	5	6
1. Canned meat	11000	12	14.4	20	No
2. Canned fish	12000	20	23	15	No
3. Canned vegetables	10000	10	14.5	45	Yes
4. Canned fruits & berries	15000	15	18	20	No
5. Confectionary	88000	100	115	15	Yes
6. Jam, honey	37000	50	65	30	Yes
7. Tea	110000	120	138	15	Yes
8. Groats & beans	23000	20	22	10	No

9. Pasta	17000	20	26	30	Yes
10. Grape wines	70000	70	80.5	15	Yes
11. Cognac	120000	100	105	5	Yes
12. Champagne	50000	60	66	10	Yes
13. Beer	25000	30	33	10	No
14.Soft drinks	20000	24	30	5	Yes

3. We determine the appropriateness of the purchase of specific items in the range:

1) We mark on the abscissa axis the point corresponding to the purchase rate of the cargo in the city *N*, and reduce its perpendicular length equal to the difference in prices (Table 1.11, column 5).

2) A conclusion on the appropriateness of procurement in the city of *N* is made if the end of the perpendicular is higher than the supplier's curve, that is, the price difference will be higher than the sum of all additional costs incurred in connection with the procurement being transferred to a remote territorial location.

Problem 1.3 for Self–Studying: "Selecting a geographically remote provider based on full cost analysis"

For your source data variant, it is advisable to determine which of the items in the assortment of company M are purchased in the city N, and which in Kiev.

Initial data:

Purchase cost, UAH. / m^3 (*OX*)	Additional costs for the delivery of 1 m^3 of cargo from the city of *N*						The share of additional costs in the purchase value, % *(OY)*
	Transport tariff, UAH / m^3	Stocks in transit, UAH	Insurance stocks, UAH	Forwarding, UAH (2 %)	The difference in unloading, UAH / m^3	Total additional costs	

1	2	3	4	5	6	7	8
5000*k	3000*k				200*k		
10000*k	3000*k				200*k		
20000*k	3000*k				200*k		
30000*k	3000*k				200*k		
40000*k	3000*k				200*k		
50000*k	3000*k				200*k		
70000*k	3000*k				200*k		
100000*k	3000*k				200*k		

Other data are not changed.

1.4. Problem "Supplier selection based on rating calculation"

The company during the year purchased goods from three suppliers P1, P2 and P3 for the production of its main products, the demand for which is growing. For this, criteria for selecting a supplier were selected, and criteria values were evaluated on a ten–point scale (Table 1.12).

Table 1.12 – Assessment of criteria for the selection of suppliers

Criteria for the selection of suppliers	Evaluation of the supplier according to criteria		
	Supplier P1	Supplier P2	Supplier P3
1. Reliable delivery	7	5	9
2. Price	6	2	3
3. Quality of components	8	6	8
4. Payment Terms	4	7	2
5. The possibility of unscheduled supplies	7	7	2
6. The financial condition of the supplier	4	3	7
TOTAL	–	–	–

It is necessary to evaluate the importance for the company of the specified criteria for evaluating suppliers and, taking this into account, calculate the rating of suppliers (table 1.13).

Table 1.13 – Calculation of the rating of suppliers

Criteria for the selection of suppliers	Criterion weight	Evaluation of the supplier according to criteria		
		Supplier P1	Supplier P2	Supplier P3
1. Reliable delivery	0.3	2.1	1.5	2.7
2. Price	0.25	1.5	0.5	0.75
3. Quality of components	0.15	1.2	0.9	1.2
4. Payment Terms	0.15	0.6	1.5	0.3
5. The possibility of unscheduled supplies	0.1	0.7	0.7	0.2
6. The financial condition of the supplier	0.05	0.2	0.15	0.35
TOTAL	1	6.3	4.8	5.5

Answer: P1 supplier has a high rating.

Problem 5. During the first two months of the year, the company received goods A and B from suppliers No. 1 and No. 2. The data on the results of work with suppliers are given in table 1.14–1.16. Make an assessment of suppliers No. 1 and 2 based on the results of work to make a decision on the extension of contractual relations with one of them.

Table 1.14 – The Dynamics of prices for goods received

Supplier	Month	Product	Scope of supply, units/month	Price, UAH/unit
№1	January	A	2000	10
	January	B	1000	5
№2	January	A	9000	9
	January	B	6000	4
№1	February	A	1200	11

	February	B	1200	6
№2	February	A	7000	10
	February	B	10000	6

Table 1.15 – Dynamics of supply of goods of inadequate quality

Month	Supplier	The quantity of goods of inadequate quality delivered during the month, units
January	№1	75
January	№2	300
February	№1	120
February	№2	425

Table 1.16 – Dynamics of violations of the established delivery time

Supplier №1			Supplier №2		
Month	Quantity of deliveries, units	Total delays, days	Month	Quantity of deliveries, units	Total delays, days
January	8	28	January	10	45
February	7	35	February	12	36

Solution. The system for evaluating the criteria in this task is based on recording the growth rate of the negative characteristics of suppliers, that is, when calculating the rating in the form of the table 1.13 it will be necessary to choose a supplier with a lower rating value.

Evaluation of suppliers should be carried out according to indicators: price, quality and reliability of the delivered goods, the importance assessments of which are respectively 10, 6 and 4. For this, it is necessary to calculate the average weighted rate of price growth (price indicator), growth rate of supply of goods of inadequate quality (quality indicator) and growth rate of average lateness (indicator of reliability of delivery).

1) Calculation of the weighted average price growth rate T_p. To assess the supplier according to the first criterion (price), it is necessary to calculate the weighted average growth rate of prices for goods supplied by him:

$$\overline{T}_p = \sum_{i=1}^{n} d_i \cdot T_{p_i}, \quad (1.4)$$

where T_{p_i} – growth rate of the price for the *i*–th type of product; d_i – the share of the *i*–th type of goods in the total volume of supplies of the current period; *n* is the number of types of goods.

The price growth rate for the *i*–th type of product is calculated by the formula:

$$T_{p_i} = \frac{P_{i_1}}{P_{i_0}} \cdot 100\%, \quad (1.5)$$

where P_{i1} for the *i*–th type of goods in the current period; P_{i0}– the price of the i–th type of goods in the previous period.

The share of the *i*–th type of goods in the total volume of deliveries is calculated by the formula:

$$d_i = \frac{S_i}{\sum S}, \quad (1.6)$$

where S_i – amount for which the goods of the *i*–th kind were delivered in the current period, UAH:

S_i = Unit Price × Delivery Volume.

The calculation of the weighted average rate of price growth is given in Table 1.17.

Table 1.17 – The calculation of the weighted average rate of price growth

Supplier	Tp_A,%	Tp_B,%	S_A	S_B	d_A	d_B	Tp,

							%
№1	110	120	13200	7200	0,65	0,35	113,5
№2	111	150	70000	60000	0,54	0,46	128,9

The obtained values of T_p are recorded in table 1.19 to calculate the vendor rating.

2) Calculation of growth rate of delivery of goods of poor quality, T_{pq}.

We calculate the growth rate of delivery of goods of poor quality for each supplier:

$$T_{\text{pq}} = \frac{d_{\text{pq}_1}}{d_{\text{pq}_0}} \cdot 100\,\%, \qquad (1.7)$$

where d_{pq1}– the share of goods of inadequate quality in the total supply of the current period; d_{pq0} – the share of goods of inadequate quality in the total volume of deliveries of the previous period. The share of goods of inadequate quality in the total supply will be determined on the basis of the data in table 1.14 and 1.15. The results are arranged in the form of a table 1.18.

Table 1.18 – Calculation of the share of goods of inadequate quality in the total supply

Month	Supplier	Total delivery, units / month	Poor quality goods share in total deliveries,%
January	№1	3000	(75/3000)*100% = 2,5
January	№2	15000	(300/15000)*100% = 2
February	№1	2400	(120/2400)*100% = 5
February	№2	17000	(425/17000)*100% = 2,5

$$T_{\text{pq1}} = 5/2.5 * 100\% = 200\ \%,$$
$$T_{\text{pq2}} = 2.5/5 * 100\% = 125\ \%.$$

The result from the calculation of T_{pq} will be entered in table 1.19.

3) Calculation of the growth rate of the average delay, T_{ad}.

The quantitative assessment of the reliability of delivery is the average delay, i.e. the number of days of delays per one delivery. This value is determined as the quotient of dividing the total number of days of delay for a certain period by the number of deliveries for the same period (table 1.16).

$$T_{ad} = \frac{O_{cp1}}{O_{cp2}} \cdot 100\%, \qquad (1.8)$$

where – O_{cp1} the average delay for one delivery in the current period, days; O_{cp2} – the average delay for one delivery in the previous period, days.

$$T_{ad1} = \left(\frac{35}{7} : \frac{28}{8}\right) \cdot 100\,\% = 142{,}9\,\%, \; T_{ad1} = \left(\frac{36}{12} : \frac{45}{10}\right) \cdot 100\,\% = 66{,}6\,\%.$$

The result will be entered in table 1.19.

Table 1.19 – Calculation of Supplier Ratings

Supplier selection criterion	Evaluation of the importance of the criterion, Ki	The proportion of the criterion, $k_i = \frac{K_i}{\sum K_i}$	Supplier 1		Supplier 2	
			Supplier Performance Assessment, B_{i1}	$K_i * B_{i1}$	Supplier Performance Assessment, B_{i2}	$K_i * B_{i2}$
Price	10	0,5	113.5	56.8	128.9	64.45
Quality	6	0.3	200	0	125	37.5
Reliability	4	0.2	142.9	28.6	66.6	13.32
Total	20	$\sum_{i=1}^{n} k_i = 1$		145.5		115.3

Answer: It is necessary to continue the contractual relationship with the second supplier as it has the least negative performance characteristics.

Problem 1.4 for Self–Studying "Choosing a provider based on its rating"

For your version of the source data, make an assessment of suppliers No. 1 and No. 2 based on the results of work to make a decision on the extension of contractual relations with one of them (task 5).

Initial data:

Supplier	Month	Product	Scope of supply, units/month	Price, UAH/unit
№1	January	A	2000*k	10*k
	January	B	1000*k	5*k
№2	January	A	9000*k	9*k
	January	B	6000*k	4*k
№1	February	A	1200*k	11*k
	February	B	1200*k	6*k
№2	February	A	7000*k	10*k
	February	B	10000*k	6*k

Other data does not change.

2 DISTRIBUTION LOGISTICS

Distribution logistics is the management of transportation, warehousing and other tangible and intangible operations performed in the process of bringing finished products to the consumer in accordance with the interests and requirements of the consumer, as well as the transfer, storage and processing of necessary information.

A distribution center is a warehouse complex that receives goods from manufacturing enterprises or from wholesalers and distributes them in small batches to customers through its or their distribution network. The task of locating distribution centers can be formulated as a search for an optimal or suboptimal (close to optimal) solution. Science and practice have developed various methods for solving problems of both types.

2.1. Method of determining the center of gravity

The method of determining the center of gravity is used to determine the location of one distribution center. For this, the method of superimposing a network of coordinates on a map of potential locations of warehouses is used. The network system makes it possible to estimate the cost of delivery from each supplier to the likely composition and from the warehouse to the final consumer, and they choose an option that is defined as the center of mass.

The coordinates of the center of gravity of cargo flows (X warehouse, Y warehouse), that is, the point at which the distribution warehouse can be located, are determined by the formulas:

$$X_{warehouse} = \frac{\sum_{i=1}^{n} B_i \times X_i}{\sum_{i=1}^{n} B_i}; \; Y_{warehouse} = \frac{\sum_{i=1}^{n} B_i \times Y_i}{\sum_{i=1}^{n} B_i}, \qquad (2.1)$$

where B_i is the cargo turnover of the *i*–th consumer; X_i, Y_i – coordinates of the *i*–th consumer; *n* is the number of consumers.

Problem 2.1. On the territory of the district there are 8 stores selling food products, their coordinates (in a rectangular coordinate system), as well as monthly freight turnover are given in table 2.1.

Table 2.1 – The Turnover and the coordinates of the stores that are served

№ of shop	Coordinate X, km	Coordinate Y, km	Turnover B, t / month
1	10	10	15
2	23	41	10
3	48	59	20
4	36	27	5
5	60	34	10
6	67	20	20
7	81	29	45
8	106	45	30

Based on the source data, it is necessary to find the coordinates of the point (*X* warehouse, *Y* warehouse) around which it is recommended to organize the work of the distribution warehouse.

Solution:

$$\bar{X}_{warehouse} = \frac{15 \cdot 10 + 10 \cdot 23 + 20 \cdot 48 + 5 \cdot 36 + 10 \cdot 60 + 20 \cdot 67 + 45 \cdot 81 + 30 \cdot 106}{15 + 10 + 20 + 5 + 10 + 20 + 45 + 30} = 66{,}35 \ Km;$$

$$Y_{warehouse} = \frac{15 \cdot 10 + 10 \cdot 41 + 20 \cdot 59 + 5 \cdot 27 + 10 \cdot 34 + 20 \cdot 20 + 45 \cdot 29 + 30 \cdot 45}{15 + 10 + 20 + 5 + 10 + 20 + 45 + 30} = 34 \ Km.$$

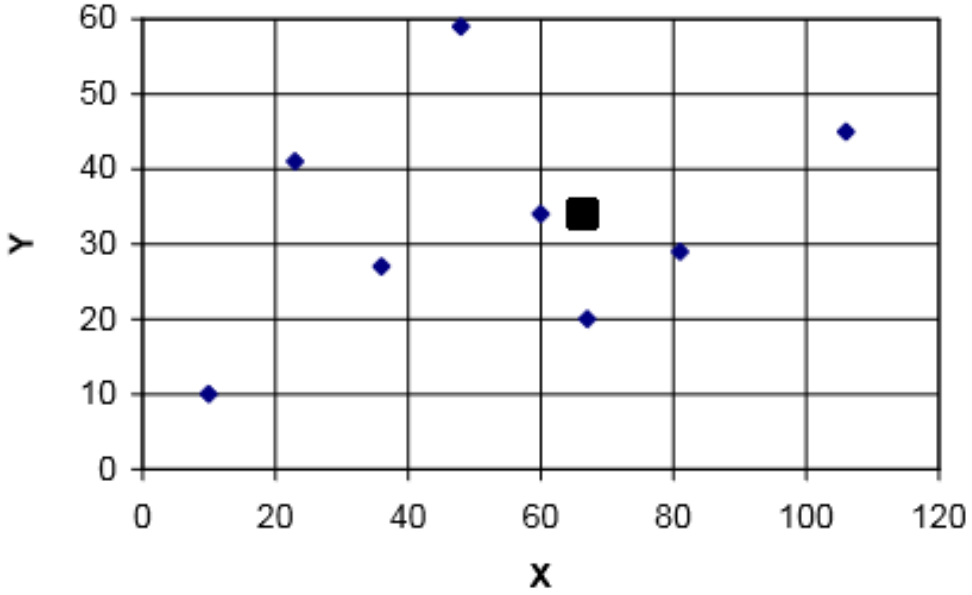

Figure 2.1 – the optimal location of the distribution warehouse

The center of mass or **the center of the equilibrium system of transport costs** is calculated by the formula:

$$M = \frac{\sum_{i=1}^{m} T_{Si} R_{Si} Q_{Si} + \sum_{i=1}^{n} T_{Ci} R_{Ci} Q_{Ci}}{\sum_{i=1}^{m} T_{Si} Q_{Si} + \sum_{i=1}^{n} T_{Ci} Q_{Ci}}, \quad (2.2)$$

where M is the center of mass, or the center of the equilibrium system of transport costs, t · km; R_{Si} – distance from the origin of the coordinate axes to the point indicating the location of the supplier, km; R_{Ci} is the distance from the origin of the coordinate axes to the point indicating the location of the client, km; T_{Ci} – transport tariff for the client for the transportation of goods, USD / t–km; T_{Si} – transport tariff for the supplier for the transportation of goods, USD / t · km; Q_{Ci} – weight (volume) of cargo sold by the i–th client, t; Q_{Si} – weight (volume) of cargo, will be shackled in the i–th supplier, t.

Let us consider the example of the definition of the center of mass or the center of the equilibrium system of transport costs.

Problem 2.2. The company engaged in the sale of products on the sales markets C_A, C_B, C_C, has regular suppliers S_1, S_2, S_3, S_4, S_5 in different regions. The increase in sales forces the company to raise the issue of building a new distribution warehouse, ensures the promotion of goods in new markets and uninterrupted supply of its customers.

Initial data:

1) tariff for suppliers for the transportation of products to the warehouse

$$T_S = 1\$/t \cdot km;$$

2) tariffs for customers for the transportation of products from the warehouse are equal:

$$T_C - C_A = 0{,}8\ \$/\ t \cdot km;\ C_B = 0{,}5\ \$/\ t \cdot km,\ C_C = 0{,}6\ \$/\ t \cdot km;$$

3) cargo weights of suppliers:

Q_S–S_1 = 150 tons, S_2 = 75 tons, S_3 = 125 tons, S_4 = 100 tons, S_5 = 150 tons.

4) the weight of goods sold to customers:

$$Q_C - C_A = 300 \text{ tons};\ C_B = 250 \text{ tons};$$

$$C_C = 150 \text{ tons}.$$

5) customer coordinates (R_{Ci}) and suppliers coordinates (R_{Si}):

Table 2.2 – Data

Coordinates	Clients			Suppliers				
	C_A	C_B	C_C	S_1	S_2	S_3	S_4	S_5
X	0	300	550	150	275	500	500	600
Y	575	500	600	125	300	275	100	550

It is necessary to determine the coordinates of the optimal location of the warehouse.

Solution:

The total cost of transporting a shipment of goods from suppliers, taking into account the distances along the *X* axis:

2. The total cost of transporting the transported consignment to customers, taking into account the distances along the *X* axis:

$$\sum T_{Si} R_{Si} Q_{Si} = T_{S1} R_{S1} Q_{S1} + T_{S2} R_{S2} Q_{S2} + T_{S3} R_{S3} Q_{S3} + T_{S4} R_{S4} Q_{S4} + T_{S5} R_{S5} Q_{S5}$$

$$= 22500 + 20625 + 50000 + 62500 + 90000;$$

along the axis *Y*:

$$\sum T_{Si} R_{Si} Q_{Si} = 168125.$$

$$\sum T_{Ci} R_{Ci} Q_{Ci} = T_{CA} R_{CA} Q_{CA} + T_{CB} R_{CB} Q_{CB} + T_{CC} R_{CC} Q_{CC} =$$

$$= 0 + 37500 + 49500;$$

along the axis *Y*:

$$\sum T_{Ci} R_{Ci} Q_{Ci} = 254500.$$

3. Coordinates of the optimal location

– along the X axis:

$$M_X = \frac{\sum_{i=1}^{5} T_{Si} R_{Si} Q_{Si} + \sum_{i=1}^{3} T_{Ci} R_{Ci} Q_{Ci}}{\sum_{i=1}^{5} T_{Si} Q_{Si} + \sum_{i=1}^{3} T_{Ci} Q_{Ci}} = \frac{245625 + 87000}{600 + 455} = 315 \text{ (km);}$$

– along the axis Y:

$$M_Y = \frac{\sum_{i=1}^{5} T_{Si} R_{Si} Q_{Si} + \sum_{i=1}^{3} T_{Ci} R_{Ci} Q_{Ci}}{\sum_{i=1}^{5} T_{Si} Q_{Si} + \sum_{i=1}^{3} T_{Ci} Q_{Ci}} = \frac{168125 + 254500}{600 + 455} = 401 \text{ (km),}$$

Answer: The optimal location of the warehouse is 315 km along the X axis and 401 km along the Y axis.

2.2. Test Point Method

The test point method allows you to determine the optimal location of the distribution warehouse in the case of a rectangular configuration of the road network in the area that is served. The essence of the method is to consistently check each segment of the serviced area.

A test point of a segment is any point located on this segment and does not apply to its ends.

The left turnover of the test point is the turnover of consumers located throughout the service area to the left of this point.

The right turnover of the test point is the freight turnover of consumers located to the right of it.

The service site is checked from its left end. First, analyze the first segment of the site: on this segment the test point belongs and the amount of cargo turnover of consumers who are to the left and right of the set point is calculated. If the cargo turnover of consumers on the right is greater, then check the next segment. If less, then a decision is made on the location of the warehouse at the beginning of the analyzed segment.

Problem 2.3. On a road section of arbitrary length (section AD) there are four consumers of material flow: A, B, C and D. The monthly volume of delivery of goods for each of them is indicated in brackets (Fig. 2.2). It is necessary to determine the optimal location of the distribution warehouse.

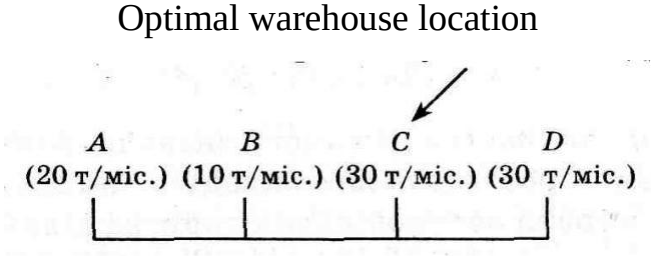

Figure 2.2 – the optimal location of the warehouse in the service area

Solution: A sequential check of each segment of the site served starting from its far left end shows that the composition will be optimal at the beginning of the CD segment (Fig. 2.2).

Problem 2.1 for Self–Studying: "Determining the location of the distribution warehouse"

On the territory of the district there are 8 stores selling food products, their coordinates (in a rectangular coordinate system), as well as monthly freight turnover are given in table 2.3. It is necessary for your source data variant to find the coordinates of the point (X warehouse, Y warehouse), in the vicinity of which it is recommended to organize the work of the distribution warehouse, and also to build the points where the stores and the warehouse are located on the same graph.

Table 2.3 – Cargo turnover and the coordinates of the stores that are served

№ of shop	Coordinate X, km	Coordinate Y, km	Turnover B, t / month
1	10*k	10*k	15
2	23*k	41*k	10
3	48*k	59*k	20
4	36*k	27*k	5
5	60*k	34*k	10
6	67*k	20*k	20
7	81*k	29*k	45
8	106*k	45*k	30

Problem 2.2 for Self–Studying. For your source data variant, determine the location of the warehouse (task 6).

Initial data:

1) tariff for suppliers for the transportation of products to the warehouse Tp = k (dollars / T · km)

2) tariffs for customers to transport products from the warehouse are equal to: $T_C – C_A$ = 0.8 * k (dollars / t · km), C_B = 0.5 * k (dollars / t · km), C_C = 0.6 * k (dollars / t · km).

Other data are not changed.

3 LOGISTICS OF STOCKS

Inventories – these are products for industrial purposes, located at different stages of production and circulation, consumer goods and other goods that are awaiting entry into the process of production or personal consumption.

3.1. Inventory management using ABC and XYZ analysis

The ABC method is a method of rationing and monitoring the state of stocks, which consists in dividing the inventory N of the implemented inventory items into three unequal subsets A, B, and C based on some formal algorithm. In the XYZ method, the entire assortment is divided into three groups depending on the uniformity of demand and the accuracy of forecasting. The use of these methods for inventory management will look at examples.

Problem 3.1. Construct the ABC analysis curve for the next set (table 3.1):

Table 3.1 – The Source Data

# of object	The contribution of the object, unit	The share of the contribution of the object,%	# of object	The contribution of the object, unit	The share of the contribution of the object,%
1	10	0.1	11	10	0.1
2	200	2	12	20	0.2
3	30	0.3	13	2300	23
4	5200	52	14	300	3
5	30	0.3	15	40	0.4
6	90	0.9	16	70	0.7
7	10	0.1	17	50	0.5
8	100	1	18	20	0.2
9	800	8	19	400	4
10	300	3	20	20	0.2
			Total	10000	100

Solution:

The procedure for the analysis of ABC.

1 Formulation of the purpose of analysis.

2 Identification of management objects are analyzed by the ABC method.

3 The selection of signs on the basis of which the classification of management objects will be carried out.

4 Evaluation of management objects by highlighted classification attribute.

5 Grouping of control objects in descending order of the value of the characteristic.

6 Construction of the curve ABC.

7 The division of the set of control objects into three groups: A, B and C. The results of the ABC analysis are shown in table 3.2 and in fig. 3.1.

Table 3.2 – Results of ABC analysis

# of object	The contribution of the object, unit	The share of the contribution of the object,%	Sort List Line Number	The number of items in an ordered list (OX axis),%	Contribution share on an accrual basis, (OY axis),%
4	5200	52	1	5	52
13	2300	23	2	10	75
9	800	8	3	15	83
19	400	4	4	20	87
10	300	3	5	25	90
14	300	3	6	30	93
2	200	2	7	35	95
8	100	1	8	40	96
6	90	0.9	9	45	96.9
16	70	0.7	10	50	97.6
17	50	0.5	11	55	98.1
15	40	0.4	12	60	98.5

3	30	0.3	13	65	98.8
5	30	0.3	14	70	99.1
12	20	0.2	15	75	99.3
18	20	0.2	16	80	99.5
20	20	0.2	17	85	99.7
1	10	0.1	18	90	99.8
7	10	0.1	19	95	99.9
11	10	0.1	20	100	100
Total	10000	100	–	–	–

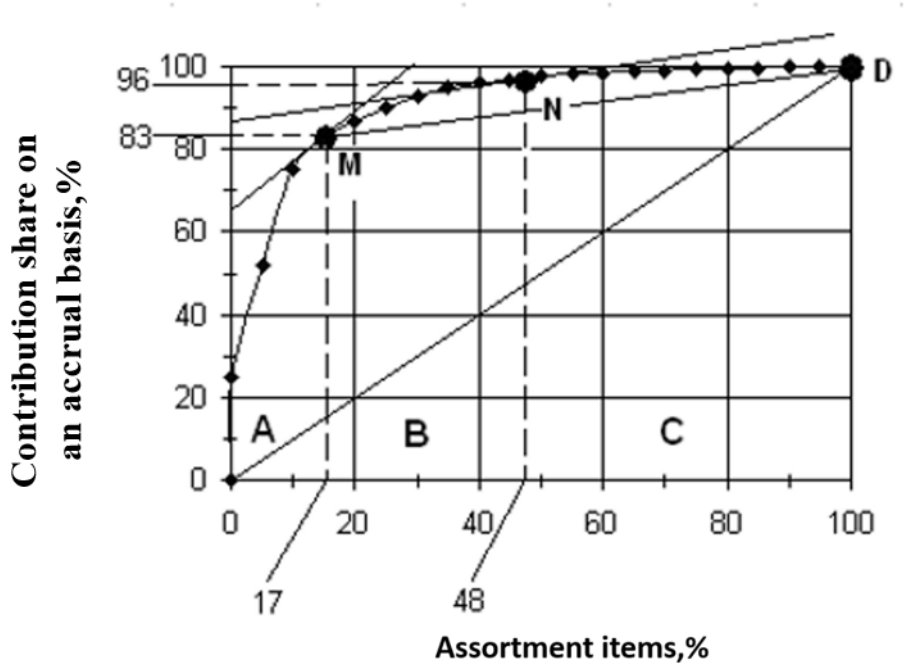

Figure 3.1 – Curve ABC analysis

Groups	Share in assortment,%	Share in sales,%
A	17	83
B	31	13
C	52	4

Problem 3.2. "Applying XYZ method"

Differentiate the assortment (Table 3.3) by the XYZ method.

Table 3.3 – Assortment for the year

Item No.	Sales per year	Sales per quarter			
		Quarter 1	Quarter 2	Quarter 3	Quarter 4
1	2600	600	620	700	680
2	800	240	180	220	160
3	3000	500	1400	400	700

Solution

A possible algorithm for differentiating the assortment into groups X, Y and Z is given in the table:

Group	Interval
X	$0 \leqslant \nu < 10\%$
Y	$10 \leqslant \nu < 25\%$
Z	$25 \leqslant \nu < \infty$

The order of XYZ analysis.

1. Determination of variation coefficients for individual items in the assortment.

2. Grouping of control objects in increasing order of coefficient of variation. 3. Construction of the XYZ curve.

4. The division of the set of control objects into three groups: X, Y and Z.

The results of the XYZ analysis are given in tables 3.4 – 3.5.

Table 3.4 – Calculation of coefficient of variation

Item No.	Quarterly average sales $\bar{x} = \frac{\sum x_i}{n}$	Dispersion $\sigma^2 = \frac{\sum (x_i - \bar{x})^2}{n}$	Standard deviation $\sigma = \sqrt{\sigma^2}$	Coefficient of Variation $\nu = \frac{\sigma}{\bar{x}} \cdot 100\,\%$
1	650	1700	41,23	6,34
2	200	100	31,62	15,81
3	750	152500	390,5	52,07

Table 3.5 – Assortment items are ordered in increasing order of coefficient of variation

Item No.	Coefficient of variation (OY axis)	Sort List Line Number	The number of positions on an accrual basis (axis OX),%	Groups (X, Y, Z)
1	6.34	1	33	X
2	15.81	2	66	Y
3	52.07	3	100	Z

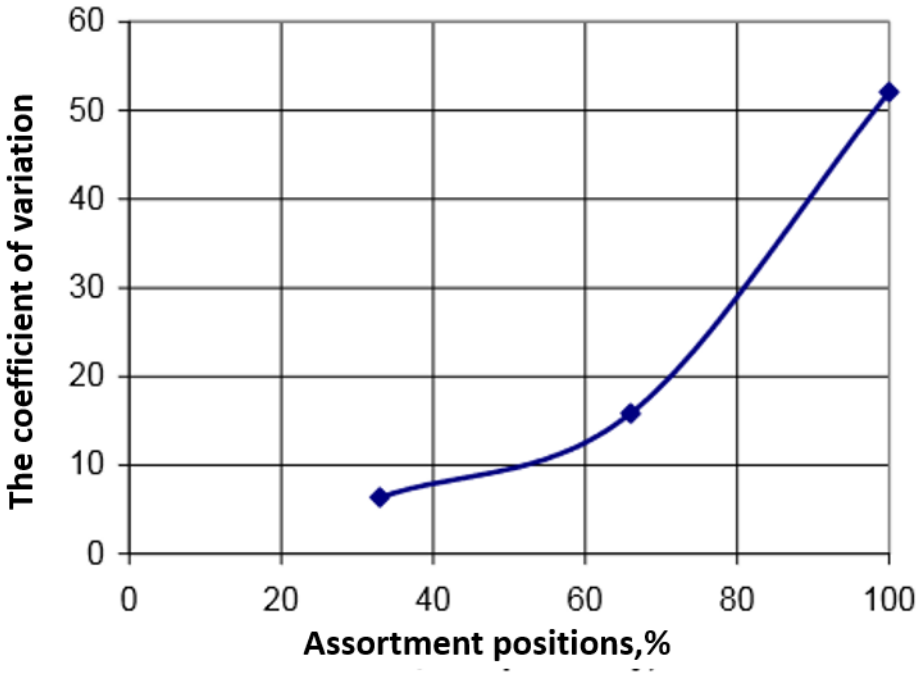

Figure 3.2 – XYZ analysis curve

Problem 3.3. "Matrix ABC – XYZ"

Build the matrix ABC – XYZ – analysis, using the data in table 3.6

Table 3.6 – Results of ABC and XYZ analysis

Results of ABC analysis				Results of XYZ analysis			
# of object	Group	# of object	Group	# of object	Group	# of object	Group

14	A	8	C	19	X	1	Y
9		17		5		20	
1		2		4		7	
20	B	16		17		9	
3		10		8		18	
7		4		11		10	
11		6		3		12	Z
15		12		6		15	
5		13		13		14	
18		19		16		2	

Solution. The matrix ABC – XYZ is compiled in the form of table 3.7.

Table 3.7 – Matrix ABC – XYZ

AX	AY	AZ
BX	BY	BZ
CX	CY	CZ

Then according to the table 3.6. matrix ABC – XYZ – analysis will look like:

–	1,9	14
3,5,11	7,18,20	15
4,6,8,13,16,17,19	10	2,12

Problem 3.1–3.3 for Self–Studying: "Inventory management using ABC and XYZ analysis"

For your version of the source data, construct the ABC analysis curve. The option is selected by the student's last name in the group's journal.

Variant 1

# of object	Contribution of the object, unit
1	7

2	23
3	45
4	75
5	90
6	260
7	345
8	510
9	1845
10	2300

Variant 2

Name of the supplier	Annual volume, UAH	Name of the supplier	Annual volume, UAH
1. OJSC Alfa	5324	8. OJSC Steel	65642
2. OJSC Metal	20000	9. OJSC Chemical machine	10023
3. LLC Omega	10352	10. PE Rubber equipment	4524
4. OJSC Motor	35641	11. OJSC Rubber equipment	10873
5. LLC Cable	13568	12. OJSC Zorya	5241
6. LLC Detail	49124	13. OJSC Polimer	5103
7. OJSC Titan	40200	14. OJSC Solar	15054

Variant 3

The range of components	Value (cost) of the stock, thousand UAH
Components 1	1630
Components 2	910
Components 3	3490
Components 4	690

Components 5	400
Components 6	230
Components 7	2850
Components 8	2160
Components 9	320
Components 10	150

Variant 4

# of object	Contribution of the object, unit
1	10
2	32
3	53
4	79
5	110
6	299
7	395
8	620
9	1930
10	2800

Variant 5

Name of the supplier	Annual volume, UAH	Name of the supplier	Annual volume, UAH
1. OJSC Vega	7944	8. OJSC Krivoy Rog Steel	93852
2. OJSC Grand	24000	9. PE Vivat	10938
3. LLC Strong	14112	10. PE Best	5544
4. OJSC Motor detail	33846	11. OJSC Rubber equipment	11238
5. LLC Cable	21408	12. OJSC Zorya	7446

sales			
6. LLC Tochdetail	54744	13. OJSC Polimer	6618
7. OJSC Titan	49200	14. OJSC Solar	12324

Variant 6

Name of the product	Annual sales, thousand UAH
Product 1	1790
Product 2	690
Product 3	560
Product 4	2500
Product 5	1200
Product 6	480
Product 7	160
Product 8	80
Product 9	340
Product 10	3610

Variant 7

The range of components	Value (cost) of the stock, thousand UAH
Components 1	350
Components 2	1900
Components 3	500
Components 4	690
Components 5	2500
Components 6	250
Components 7	2100
Components 8	810
Components 9	180
Components 10	450

Variant 8

Kind of juice	Annual sales	Kind of juice	Annual sales
1. Orange	8888,57	8. Exotic juice	2233,11
2. Apple	4586,71	9. White grape	2062,25
3. Cherry	4491,83	10. Blackcurrant	1745,06
4. Multivitamin	4365,24	11. Apple	1158,44
5. Grapefruit	3165,07	12. Plumb	1167,48
6. Tomato	258,63	13.Multifruit	682,04
7. Apricot	2245,49	14. Pear	573,2

Variant 9

Suppliers	Annual sales, thousand UAH
1	400
2	1300
3	2000
4	12000
5	700
6	8000
7	3000
8	300
9	200
10	500

Variant 10

Type of stock	Stock volume, thousand UAH
1	10
2	200
3	5100
4	30
5	80

6	90
7	60
8	100
9	800
10	300

3.2. Determination of the optimal order size for the component product

The indicator of the **optimal (economic) order size** expresses the power of the material flow sent by the supplier to the customer's order, and which provides the consumer with a minimum value of the sum of two logistic components: transportation and procurement costs and expenses for the formation and storage of stocks.

Problem 3.4. According to cost accounting, it is known that the cost of submitting one order is 200 UAH. The annual need for components is 1550 pcs., The unit price of the componentry is 560 UAH. The cost of maintaining the componentry in the warehouse is 20% of its price. Determine the optimal order size for the component product.

Solution.

The optimal order size (economic order quantity – EOQ) is determined by the Wilson formula:

$$EOQ = \sqrt{\frac{2C_0 S}{C_i U}}, \qquad (3.1)$$

where EOQ is the optimal order size, units; C_0 – the cost of fulfilling the order, rubles; C_i – the purchase price of a unit of goods, rubles; S – annual sales, units; U is the share of storage costs in the price of a unit of goods.

$$EOQ = \sqrt{\frac{2 \cdot 200 \cdot 1550}{0{,}2 \cdot 560}} = 74{,}402 \text{ (units).}$$

To avoid a shortage of components, you can round the optimal order size up. Thus, the optimal order size for the component product is 75 pcs. So, during the year you need to place 21 (1550/75) orders.

3.3. Inventory Management Systems

An inventory management system is a set of rules and indicators that determine the point in time and the volume of procurement of products to replenish stocks. The following inventory management systems are distinguished: 1) with a fixed order size; 2) with a fixed time interval between orders; 3) with the established frequency of replenishment of stocks to a constant level. Consider the calculation of the parameters of these systems using an example.

Problem 3.5. The annual need for materials is 1550 pcs. The number of working days in a year is 226 days, the optimal order size is 75 pcs. Delivery time – 10 days, a delay in deliveries of 2 days is possible. Define the parameters of inventory management systems of three types: 1) with a fixed order size; 2) with a fixed time interval between orders; 3) with the established frequency of replenishment of stocks to a constant level.

Solution.

1. Inventory management systems with a fixed order size.

The calculation results of the parameters of the inventory management system with a fixed order size are given in table 3.8 and in fig. 3.3.

Table 3.8 – Calculation of the parameters of the inventory management system with a fixed order size

№	Index	Calculation procedure	Value
1	Need, pcs.	–	1550
2	Optimal order size, pcs.	–	75
3	Delivery time, days	–	10
4	Delay in delivery, days	–	2

5	Estimated daily consumption, pcs. / Day	[1] : number of working days	7
6	Term of the order, days	[2] : [5]	11
7	Expected consumption during delivery, pcs.	[3] * [5]	10
8	Maximum consumption during delivery, pcs.	([3] + [4]) * [5]	84
9	Warranty stock, pcs.	[8] – [7]	14
10	Threshold level of stock, pcs.	[9] + [7]	84
11	Maximum desired stock	[9] + [2]	89
12	Term stock costs up to the threshold level, days	([11] – [10]) : [5]	1

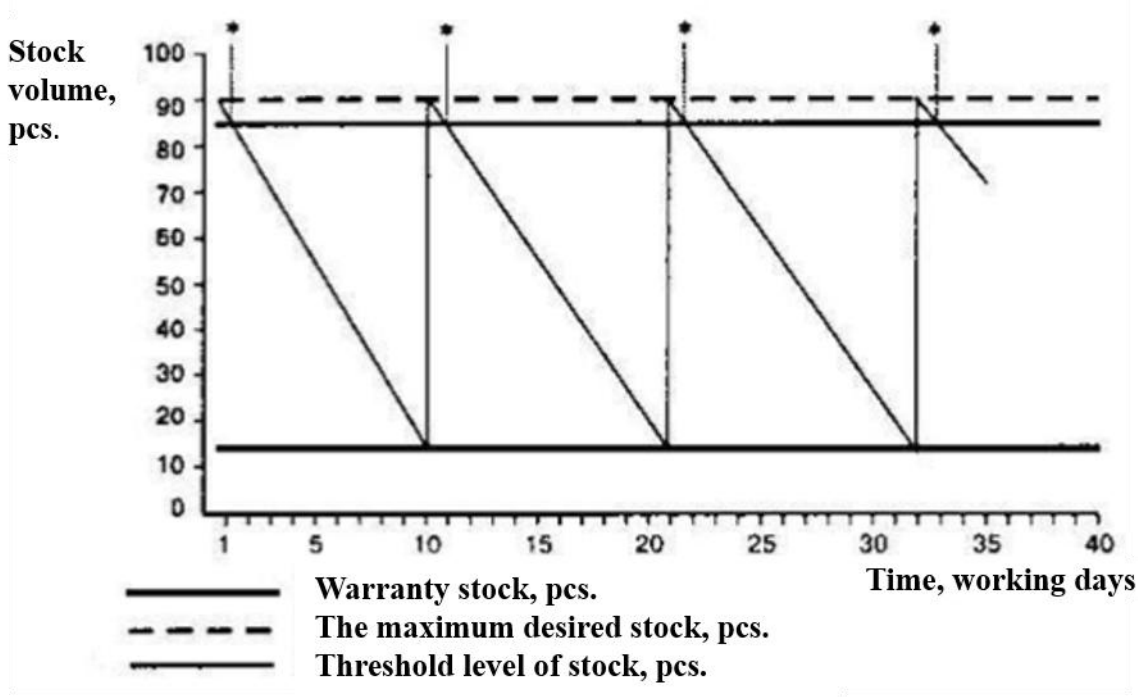

Figure 3.3 – Graphic model of the fixed–order inventory management system without disruptions in supply

2. Stock management systems with a fixed time interval between orders

The time interval between orders is determined by the formula:

$$I = N \cdot EOQ/S, \quad (3.2)$$

where I is the time interval between orders, days; N – number of working days in the period, days; EOQ – optimal order size; S – need, pcs.

$$I = 226 \cdot 75/1550 = 10{,}94 \approx 11 \text{ (days)}.$$

The order size on a fixed time interval system looks like:

$$SO = MDS – CO + EC, \quad (3.3)$$

where SO – the size of the order, pcs; MDS – maximum desired stock, units; CO – current order, pcs; EC – expected consumption during delivery, pcs.

$$SO = 91 – 84 + 70 = 77.$$

The results of calculating the parameters of the inventory management system with a fixed time interval between orders are given in table 3.9.

Table 3.9 – Calculation of the parameters of the inventory management system with a fixed time interval between orders

№	Index	Calculation procedure	Value
1	Need, pcs.	–	1550
2	Time interval between orders, days	(3.1)	11
3	Delivery time, days	–	10
4	Delay in delivery, days	–	2
5	Estimated daily consumption, pcs. / Day	[1] : number of working days	7
6	Expected consumption during delivery, pcs.	[3] * [5]	70
7	Maximum consumption during delivery, pcs.	([3] + [4]) * [5]	84
8	Warranty stock, pcs.	[7] – [6]	14
9	Maximum desired stock	[8] + [2] * [5]	91
10	Order size	(3.3)	77

$$SO = 161 – 84 + 70 = 147 \text{ (unit)}.$$

Problem 3.5 for Self–Studying: “Inventory management systems”

For your source data variant, calculate the parameters of inventory management systems of three types: 1) with a fixed order size; 2) with a fixed time interval between orders; 3) with the established frequency of replenishment of stocks to a constant level.

Legend: S – annual need for goods, units; N is the number of working days in the period; t – delivery time, days; EOQ – optimal order size; D – possible delay in deliveries, days.

Initial data: EOQ = 75 units; N = 226 days.

Variant	S	t	D
1	1200	5	2
2	1320	6	2
3	1595	3	1
4	1800	8	3
5	1460	12	6
6	1555	3	1
7	1820	6	1
8	1160	5	2
9	1230	4	1
10	1580	11	2
11	1470	13	6
12	1365	5	2
13	1520	9	4
14	1100	7	2
15	1095	3	1
16	1020	6	3
17	1960	5	1
18	1355	13	5
19	1640	11	4
20	1685	16	5
21	1670	8	3
22	1930	9	3
23	1345	7	3
24	1235	4	2
25	1495	5	2

4 WAREHOUSE LOGISTICS

4.1 Decision–making on the use of hired staff services

The determination of the actual cost of cargo handling at the warehouse allows us to make informed decisions on the critical composition.

A wholesaler today most often has to choose between organizing his own warehouse and using a public warehouse for stocking. In the latter case, the warehouse owner includes the implementation of logistics operations in the storage cost.

The choice between own and hired staff can be determined from the graph presented in Fig. 4.1.

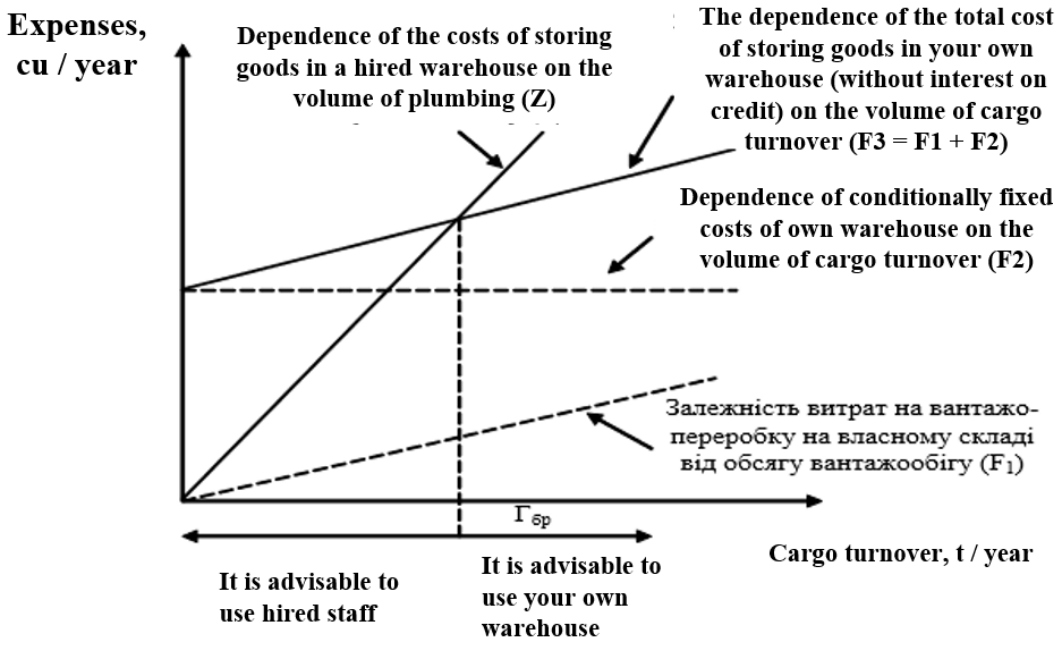

Figure 4.1 – The decision on the use of own or hired staff

This problem can be solved with a sufficient degree of accuracy only if the nature of the dependence of the costs of cargo processing in your own warehouse on the volume of relevant work is known, that is, if the warehouse has operational accounting of logistics costs.

Problem 4.1. To determine the cargo turnover at which the company is equally satisfied with owning or using the services of a hired warehouse, according to the table 4.1.

Table 4.1 – Data for calculating storage costs

Indicator	Dimension	Value
1. The specific cost of cargo handling in our own warehouse	conventional units / t	4,6
2. The fixed costs of own warehouse	conventional units / year	36000
3. Tariff for leased warehouse services	conventional units per 1 m^2 per day	0,4
4. The size of the stock in days of turnover	days	66
5. The number of working days per year	days	300
6. Load per 1 m^2 of area when stored in a leased warehouse	t / m^2	2,1

Solution

Stages of the assignment

1. Determine the costs of storage in its own composition.

2. Determine the cost of storage in a removable composition.

3. Build expense schedules. Determine the feasibility zones for the use of warehouses.

4. Derive the formula for determining the "freight turnover of indifference."

1. The cost of cargo processing in our own warehouse (F_1) is determined by the formula

$$F_1 = C_{CargoHandling} \cdot T, \qquad (4.1)$$

where T – annual turnover, т/year; $C_{CargoHandling}$ – unit cost of cargo handling at own warehouse, c.u./t.

$$F_1 = 4{,}6 \cdot 1000 = 4600 \text{ c.u./year.}$$

Similarly, we carry out calculations for other values. The calculation results are presented in the form of a table 4.2.

Table 4.2 – The results of the calculation of the cost of conservation

Index	The value of the indicator for various cargo turnover (T, t/year)				
	T =1000	T =3000	T =5000	T =7000	T =9000
1. Own freight handling costs	4600	13800	23000	32200	41400
2. The cost of storage in your own warehouse	40600	49800	56000	68200	77400
3. The required area of the leased warehouse	105	314	524	733	943
4. Storage costs in a leased warehouse	15330	45844	76504	107018	137678

The cost of storage in our own warehouse is determined by the formula

$$F_3 = F_1 + F_2, \tag{4.2}$$

where F_2 – fixed costs of own warehouse, c.u./year.

$$F_3 = 4600 + 36000 = 40600 \text{ c.u./year.}$$

Similarly carry out calculations for other values. The calculation results are presented in the form of a table 4.2.

2. We plot the cost of storage in a rented warehouse (Z) based on the tariff rate for storage of goods in a rented warehouse.

The dependence of Z is determined by the formula

$$Z = \alpha \cdot S_l \cdot 365, \tag{4.3}$$

where α – daily cost of using the cargo area of the leased warehouse (tariff for services of the leased warehouse); S_l – required area of the leased warehouse, m^2; 365 – the number of days of storage at the leased warehouse per year.

The calculation of the required area of the leased warehouse is performed according to the formula

$$S_l = \frac{\text{Stock Size} \cdot T}{D \cdot \eta}, \qquad (4.4)$$

where Stock Size – stock size in days of turnover; D – number of working days per year; η – load per 1 m^2 of area when stored in a leased warehouse , t/m^2.

$$S_l = \frac{66 \cdot 1000}{300 \cdot 2.1} = 105 \quad (m^2)$$

$$Z = 0{,}4 \cdot 105 \cdot 365 = 15330 \text{ c.u./year.}$$

Similarly, calculations are carried out for other values. The calculation results are presented in the form of a table 4.2.

3. We construct the function graph from the assumption that it has a linear character. The graph is built on graph paper or using a graphical editor on a computer. Based on the graph, we find the values of the "cargo turnover of indifference".

According to the example, the graph is shown in Fig. 4.2.

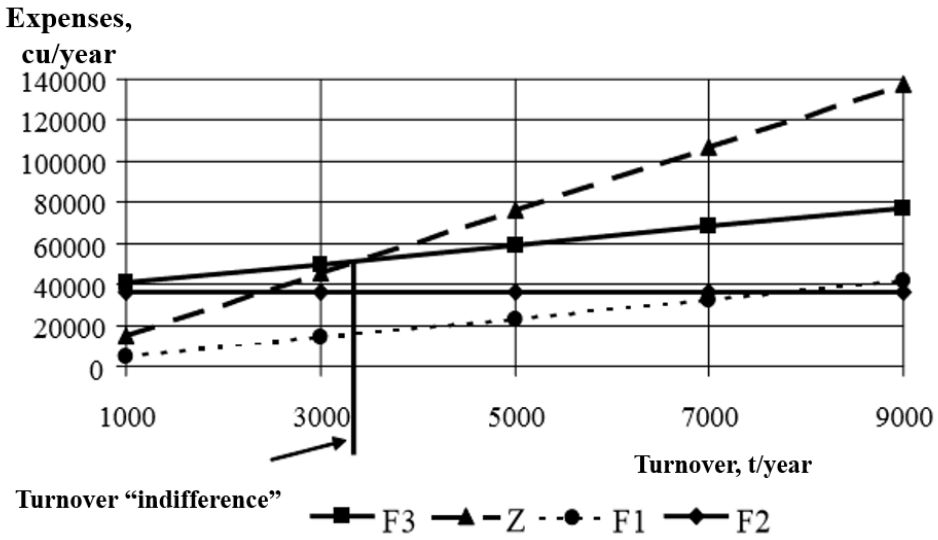

Figure 4.2 – a Graphic definition of the turnover of "indifference"

4. Using formulas for calculating storage costs, we obtain the dependence of cargo turnover on the conditions of use of the warehouse. On the obtained dependence, we will verify the correctness of the definition of "freight traffic of indifference", which was obtained using the graph.

Problem 4.1 for Self–Studying: "Making a decision about using the services of a leased warehouse"

For your source data variant, determine the freight turnover at which the company is equally satisfied with owning or using the services of a leased warehouse.

Indicator	Dimension	Value
1. The specific cost of cargo handling in our own warehouse	c.u. / t	4,6*k
2. The fixed costs of own warehouse	c.u. / year	36000*k
3. Tariff for leased warehouse services	c.u. per 1 m2 per day	0,4*k
4. The size of the stock in days of turnover	days	66
5. The number of working days per year	days	300
6. Load per 1 m2 of area when stored in a leased warehouse	t / m2	2,1

Problem 4.2 "Calculation of the break–even point of the warehouse"

The break–even point is the minimum volume of activity, i.e. the volume below which the work of the enterprise becomes unprofitable

The calculation of the break–even point of the warehouse is to determine the turnover at which the profit of the enterprise is zero. The calculation of the minimum cargo turnover will allow reaching the minimum warehouse size, the minimum possible number of equipment and personnel.

Initial data. Data on the operation of the warehouse are presented in table 4.4.

Table 4.4 – The economic performance of the warehouse

Indicator	Dimension	Value
The average cost of purchasing goods, *R*	c.u. /t	6000

The coefficient for calculating the payment of interest on the loan, *k*	–	0.045
Trade allowance for the wholesale of goods, *N*	%	7.8
The cost of renting a warehouse, C_{WR}	c.u. /year	170000
Depreciation of equipment, C_{DE}	c.u./year	30000
The cost of electricity, C_E	c.u./year	80000
The cost of paying management personnel and specialists, C_{Salary}	c.u./year	20000
The cost of cargo handling per 1 ton of warehouse turnover, $C_{CargoSpecific}$	c.u./t	14
Existing warehouse turnover, *T*	t/year	1600

Solution.

Stages of solving the problem

1. Calculate the total cost of the warehouse.
2. Determine the profit of the warehouse.
3. Determine the breakeven point.

1. The total cost of the warehouse is determined by the formula

$$C_{Total} = C_{Var} + C_{Fixed}, \quad (4.5)$$

where C_{Fixed} – fixed costs, c.u./year; C_{Var} – variable costs, c.u./year.

Fixed costs is determined by the formula

$$C_{Fixed} = C_{WR} + C_{DE} + C_E + C_{Salary}, \quad (4.6)$$

where C_{WR} – the cost of renting a warehouse, c.u./year; C_{DE} – the cost of depreciation of equipment, c.u./year; C_E – the cost of electricity, c.u./year; C_{Salary} – the cost of paying management personnel and specialists, c.u./year.

Variable costs is determined by the formula

$$C_{Var} = C_{Loan} + C_{CargoHandlng}, \quad (4.7)$$

where C_{Loan} – loan expenses, cu/year; $C_{CargoHandlng}$ – cargo handling costs, c.u./year.

Loan costs are found by the formula

$$C_{Loan} = k \cdot T \cdot R, \quad (4.8)$$

where k – coefficient taking into account payment of interest on a loan; T – warehouse turnover (incoming or outgoing flow), t/year; R – average cost of purchasing goods, c.u./t.

The cost of cargo handling is determined by the formula

$$C_{CargoHandling} = C_{CargoSpecific} \cdot T, \quad (4.9)$$

where $C_{CargoSpecific}$ – cargo handling cost per 1 ton of warehouse turnover, c.u./t.

The calculation results are introduced in table 4.5.

Fixed costs				Variable costs		Total expenses	Income	Profit
The cost of renting a warehouse	The cost of depreciation of equipment	The cost of electricity	The cost of paying management personnel and specialists	Loan costs	The cost of cargo handling			

2. The profit of the warehouse is determined by the formula

$$P = WR - C_{Total}, \quad (4.10)$$

where WR – warehouse revenues, c.u./year. It is determined by the formula

$$WR = \frac{T \cdot R \cdot N}{100}, \quad (4.11)$$

where N – trade allowance for the wholesale of goods, %.

3. The breakeven point is determined on the basis of the calculation of warehouse profits. To do this, instead of the value of the existing freight turnover (T), the freight turnover is substituted into the profit calculation

formula, which will allow the warehouse to operate at zero profit (T_{Opt}). Next, the resulting expression is equated to zero and find the desired cargo turnover.

$$\mathrm{P} = \frac{T_{\mathrm{Opt}} \cdot R \cdot N}{100} - k \cdot T_{\mathrm{Opt}} \cdot R - \mathrm{C}_{\mathrm{CargoSpecific}} \cdot T_{\mathrm{Opt}} - \mathrm{C}_{\mathrm{Fixed}},$$

(4.12)

$$\frac{T_{\mathrm{Opt}} \cdot R \cdot N}{100} - k \cdot T_{\mathrm{Opt}} \cdot R - \mathrm{C}_{\mathrm{CargoSpecific}} \cdot T_{\mathrm{Opt}} - \mathrm{C}_{\mathrm{Fixed}} = 0,$$

(4.13)

$$T_{\mathrm{Opt}} = \frac{100 \cdot \mathrm{C}_{\mathrm{Fixed}}}{R \cdot N - 100 \cdot k \cdot R - 100 \cdot \mathrm{C}_{\mathrm{CargoSpecific}}}.$$

(4.14)

Based on the values of T and T_{Opt}, conclude that the warehouse is unprofitable and profitable To verify the correctness of the calculations, build graphs of the dependence of income and total costs on the values of cargo turnover.

Problem 4.2 for Self–Studying: "Calculation of the break–even point of the warehouse"

For your version of the source data, determine the breakeven point of the warehouse.

Table 4.6 – Economic indicators of the warehouse

Indicator	Dimension	Value
The average cost of purchasing goods, *R*	c.u. /t	6000*k
The coefficient for calculating the payment of interest on the loan, *k*	–	0.045
Trade allowance for the wholesale of goods, *N*	%	7.8
The cost of renting a warehouse, C_{WR}	c.u. /year	170000*k
Depreciation of equipment, C_{DE}	c.u./year	30000*k
The cost of electricity, C_E	c.u./year	80000*k
The cost of paying management personnel and specialists, C_{Salary}	c.u./year	20000*k

The cost of cargo handling per 1 ton of warehouse turnover, $C_{CargoSpecific}$	c.u./t	14*k
Existing warehouse turnover, *T*	t/year	1600

EXAM QUESTIONS

1. Define logistics as a science.
2. Give a definition of logistics business.
3. What is the fundamental difference between the logistic approach to managing material flow from the traditional?
4. Describe the main stages in the development of logistics.
5. What is the main goal of logistics management?
6. Expand the contents of macro logistics.
7. What are the functions of logistics? Expand their content.
8. Expand the content of micro–logistics.
9. What is material flow? What are its main indicators?
10. List the types of material flows.
11. Give a definition of the logistics operation and list its types.
12. What is a system and what are its properties?
13. Give a definition of the logistics system. What is its purpose?
14. Describe the micro–logistical system and its subsystems.
15. Uncover the essence of macro–logical systems.
16. Give the classification of logistics systems depending on the type of logistics chains.
17. Give the definition of the logistics channel and the supply chain.
18. What is procurement logistics? What is its purpose?
19. Give the main objectives of the procurement logistics.
20. List the benefits of external procurement and domestic production.
21. What are the main steps to solving the problem of choosing a supplier?
22. Define the concept of the economic size of the order.
23. What is the just–in–time supply chain in procurement logistics?
24. What is production logistics? What is its purpose?
25. Give a definition of intra–production logistics systems. What is their role at the macro and micro level?
26. What tasks does production logistics solve?
27. Describe the traditional concept of organization of production.
28. What is the essence of the logistic concept of production organization?
29. Uncover the essence of the pushing system.
30. What is a pulling system?

31. Describe the logistics concept of MRP.

32. Expand the operating principle of the KANBAN logistics system.

33. What is the essence of the OPT logistics system?

34. Describe the lean manufacturing logistics system.

35. Define the concept of "distribution logistics".

36. List the tasks of distribution logistics at the micro and macro levels.

37. What is a distribution channel and distribution network? 38. Give a classification of logistic distribution channels.

39. List the functions that intermediaries perform in distribution channels.

40. Describe the main types of resellers.

41. Describe the various types of distribution systems.

42. Define the concept of "transportation" and list its types.

43. List the tasks that transport logistics solves.

44. Describe the main groups of transport.

45. Give a classification of the transport component of logistics systems.

46. Describe the main advantages and disadvantages of rail, water, road, air and pipeline transport.

47. What factors can affect the choice of mode of transport?

48. Define the concept of "material stock".

49. List the main types of inventories.

50. What is the essence of the ABC analysis method in inventory management?

51. Expand the essence of the method of XYZ analysis.

52. Describe the inventory management system with a fixed order size.

53. Expand the essence of inventory management systems with a fixed time interval between orders.

54. Describe the inventory management system with the established frequency of replenishment of reserves to a constant level.

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Навчально–методичне видання

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до практичних занять з курсу «Міжнародна логістика»

для студентів спеціальностей

073 «Менеджмент»

076 «Підприємництво, торгівля та біржова діяльність»

Укладачі: ШИРЯЄВА Наталя Володимирівна

МАКАРЕНКО Анастасія Борисівна

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